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ABSTRACT

The Computer Self-Efficacy Scale (CSE) developed by C. A. Murphy, D. Coover, and S. V. Owen (1989) is an instrument purported to assess computer-related competencies. Previous research into the factor structure of the CSE has yielded conflicting results. In this study, the scale was used to collect data from 216 graduate education students. A principal factor analysis with orthogonal rotation generated a four-factor solution with high alpha reliabilities. Additional analysis supported the convergent and discriminant validity of the scale with measures of computer confidence and computer anxiety. Results suggest that the scale also differentiates between users with high and low amounts of computer use experience. Results support previous research that indicates that the amount of experience people have with computers has an effect on their perceptions of self-efficacy for computer-related tasks. (Contains 3 tables and 31 references.) (Author/SLD)

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Assessing and Improving the Factorial Structures of the Computer Self-efficacy Scale

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Abstract

Previous research on the factorial structure of the Computer Self-efficacy scale has yielded conflicting results. In this study, the scale was used to collect data from 216 graduate education students. A principal factor analysis with orthogonal rotation generated a four-factor solution with high alpha reliabilities. Additional analysis supported the convergent and discriminant validity of the scale with measures of computer confidence and computer anxiety. Results suggested that the scale also differentiates between high and low computer users.

Busch (1995) defined self efficacy as "the belief in one's ability to execute successfully a certain course of behaviors" (p. 147). Thus, as a psychological construct, self efficacy plays a crucial role in self motivation. Any instrument that measured such beliefs could aid in the evaluation of new programs or in the identification of potential problems in implementing technology-related tasks. Such an instrument, of course, should be reliable and valid. Routed in Bandura's social-cognitive theory (1986), the Computer Self-efficacy Scale (CSE) is one such instrument purporting to assess computer-related competencies.

Murphy, Coover and Owen (1989) developed the 32 item Computer Self-efficacy Scale (CSE) to measure perceptions of respondents' capabilities regarding specific computer-related skills and knowledge. The items were developed after careful review of the literature and analysis of the skills emphasized in three different graduate courses designed to teach micro and mainframe computer-related skills. The instrument employs a 5-point Likert-style response format, with each item preceded by "I feel confident". All items are positively worded and an individuals' self efficacy score is calculated by summing item responses. High scores indicate a high degree of confidence in one's ability to use computers.

Murphy et al. used a sample of 414 students and nurses with which to factor analyze the CSE. A principal factor analysis with oblique rotation produced a three-factor solution. These factors were labeled as 1) Beginning-Level Computer Skills (16 items), 2) Advanced-Level Computer Skills (13 items), and 3) Mainframe Computer Skills (3 items). The coefficient alpha reliabilities for the derived factors were .97, .96, and .93 respectively. A known group analysis, in terms of gender, showed significant differences for advanced and mainframe skills: women held lower self efficacy beliefs than men. Criterion or convergent validity was not examined.

A later study by Harrison and Rainer (1992a) examined the factor structure and concurrent validity of the CSE with one measure of computer attitudes and another of

computer anxiety: Nickell and Pinto's Computer Attitude Scale (1987) and the Computer Anxiety Rating Scale developed by Heinssen, Glass, and Knight (1987). Analyzing data collected from a sample of 776 salaried university personnel, Harrison and Rainer used a principal factor orthogonal rotation and report similar structures to those identified by Murphy et al. Harrison and Rainer also note that subscales 1 and 2 (Beginning-Level Computer Skills and Advanced-Level Computer Skills) correlate more highly ($r = .68$) than CSE 1 and 3 ($r = .35$) and 3 and 2 ($r = .54$). As a result, Harrison and Rainer conclude that the Beginning-Level Computer Skills and Advanced-Level Computer Skills subscales appear to represent confidence in microcomputer skills, rather than mainframe skills. Harrison and Rainer report moderate correlation's between the CSE subscales and the Computer Attitude Scale and the Computer Anxiety Rating Scale subscales.

In a more recent study, Torkzadeh and Koufteros (1994) examined the psychometric properties of the CSE with a sample of 224 undergraduate students enrolled in computer-skill specific training courses. Principal component factor analysis with oblique rotation of posttraining responses yielded four, not three, factor structures. Torkzadeh and Koufteros name these dimensions as 1) Beginning Computer Skills (10 items), 2) Mainframe Computer Skills (3 items), 3) Advanced-Level Computer Skills (10 items), and 4) Computer File and Software Management (7 items). Coefficient alpha reliabilities were reported as .94, .96, .90, and .91 respectively. It must be noted, however, that Torkzadeh and Koufteros use a shortened version of the CSE (30 items of the original 32) in their validation study. Gender differences were found in mean scores at pretraining testing for Factor 4, Computer File and Software Management. Posttraining results indicated no significant differences in scores for either gender in any of the four factors.

Whilst the Harrison and Rainer (1992a) and Torkzadeh and Koufteros (1994) studies provide useful psychometric information about the CSE, both have limitations. Harrison and Rainer (1992a), for example, use a comparison measure of computer attitude

still under development, whilst Torkzadeh and Koufteros omit two items for their 1994 study. The current research, therefore, builds on these previous studies by (1) examining the concurrent validity of the CSE with an instrument that has demonstrated sound reliability and validity, and (2) exploring the factorial structure of the original 32 item CSE. More specifically, the purpose of the present study was: a) to gain information concerning the factorial validity of the subscales, b) to obtain estimates of the reliability of the CSE; c) investigate the convergent and discriminant validity of the CSE; and, d) to provide evidence about the differential validity of the scores (i.e., to ascertain the ability of the CSE to differentiate between two groups with different amounts of computer usage experience).

Research Design

Messick (1989) defines convergent validity as "evidence that signifies that the measure in question is coherently related to other measures of the same construct as well as to other variables that is should relate to on theoretical grounds" (p. 36). Conversely, discriminant validity signifies that a test or measure is not related to exemplars of other distinct constructs. With this paradigm in mind, a review of the literature revealed that anxiety would be an appropriate construct with which to explore the discriminant validity of the CSE. A number of studies have shown that people who exhibit computer anxiety are prone to behaviours that impede the process of learning how to use a computer (Gardner, Discenza, and Dukes, 1993). Further, Harrison and Rainer (1992b) found a negative correlation between anxiety and perceived computer-related skills. Research has also shown that the amount of experience a person has with computers appears to be a significant factor in an individual's judgment of self-efficacy for computer-related tasks: (Ertmer, Evenbeck, Cennamo, and Lehman, 1994; Loyd and Loyd, 1985; Loyd and Gressard, 1984b). Computer experience is also related to computer anxiety (Loyd and Gressard, 1986) and to computer attitudes in general (Bear, Richards, and Lancaster, 1987). Thus, Loyd and Gressard's Computer Attitude Scale (1984a), with subscales of Computer Confidence and Computer Anxiety, was selected to satisfy the conditions for

establishing convergent and discriminant validity. An additional scale was developed to ascertain computer experience levels of the sample in order for known group differentiation analysis to take place.

Method

Instrumentation

Computer Self-efficacy Scale. The 32 item Computer Self-efficacy Scale (CSE) was used as presented by Murphy, Coover and Owen (1989). Each item of the scale was preceded by the phrase, "I feel confident". As in earlier studies, a 5-point Likert-style response format was used (1 = Strongly Disagree, 2 = Disagree, 3 = Not Sure, 4 = Agree, and 5 = Strongly Agree.). Total and subscale scores were calculated by summing individual responses. High scores indicated a high degree of confidence in one's ability to use computers.

Computer Attitude Scale. The Computer Attitude Scale (CAS) developed by Loyd and Gressard (1984a) consists of 40 likert-type items covering four subscales: Computer Confidence, Computer Anxiety, Computer Liking, and Computer Usefulness. Fast becoming the measure of choice in research on computer attitudes (Gardner, Discenza, and Dukes, 1993), the reliability and validity of the CAS has been extensively researched aside from its original development (further discussion on the psychometric properties of the CAS can be found in Francis and Evans, 1995; Szajna, 1994; Gardner et al., 1993; LaLomia and Sidowski, 1993; Woodrow, 1991; Bandalos and Benson 1990; Roszkowski, Devlin, Snelbecker, and Jacobsohn, 1988; Gressard and Loyd, 1986; Loyd and Loyd, 1985). All of these studies support the reliability of the CAS with a variety of populations. For example, Francis and Evans (1995) reported alpha coefficients of .92 for the computer anxiety subscale, .90 for the computer confidence subscale, .91 for the computer liking subscale, and .96 for the instrument as a whole. Validation methodologies of the CAS have encompassed known group differentiation, factor analysis, construct and criterion studies. Furthermore, the CAS was chosen because of its previous use with similar

populations to that of this study. For example, the CAS has been used to assess the attitudes towards computers of college students (Busch, 1995; Szajna, 1994; Carlson and Wright, 1993; Pope-Davis and Vispoel, 1993; Bandalos and Benson 1990) and professional educators (Nash and Moroz, 1997; Bennett, 1995; Kluver, Lam, Hoffman, Green, and Swearingen, 1994; Mertens and Wang, 1988; Loyd and Gressard, 1986). For the present study, two of the CAS subscales were selected: Computer Confidence and Computer Anxiety. Both these subscales consist of 10 items constructed as personal statements (positively and negatively worded). The Computer Confidence subscale contains items like, "I have a lot of self-confidence when it comes to working with computers." The Computer Anxiety subscale has items like, "computers make me feel uncomfortable." Like the CSE, the following 5-point rating scale was used to score the CAS subscales: 1 = Strongly Disagree, through 5 = Strongly Agree.

Computer Experience. In order to ascertain levels of computer usage in this study, the questionnaire contained items developed to collect data pertaining to the samples' frequency and intensity of computer-related activities. Computer-related activities was divided into two locations: at home and at work. The subjects were asked to indicate the frequency with which they used a computer at work for: 1) programming, 2) accessing the internet, 3) wordprocessing, 4) retrieving and composing electronic mail, 5) paint/draw/or other graphical activities, and 6) spreadsheet/numerical/statistical analyses. The same computer usage categories were presented for the 'at home' locale, plus an additional 'recreational purposes' item. The responses of all 13 items were recorded on a 5-point scale with 1 (for never), 2 (for occasionally in a year), 3 (for once a month), 4 (for once a week), and 5 (for daily). The items and response patterns were selected as appropriate indicators of computer usage because they provide for a more thorough analysis of computer-related behaviours than more typical measures of 'experience' (which concentrate on length of time, as oppose to the intensity and consistency, of computer experience).

Subsequent internal reliability analyses of the data yielded by the computer experience items revealed Cronbach's alpha of .86 (home) and .82 (work).

Subjects

The subjects for this study were 216 students at a predominantly Hispanic southwestern university enrolled in graduate level education courses. 152 of the sample were female and 63 were male (1 was unknown). Participation in the study was voluntary.

General Procedures

The subjects were administered the CSE and two CAS subscales at the beginning of their courses as part of a larger federally funded study investigating attitudes towards computers. Item responses were coded so that a higher score indicated a higher degree of perceived computer confidence (CSE subscales and CAS Computer Confidence subscale), anxiety (CAS Computer Anxiety subscale), and computer usage (at home and at work). SPSS (1995) was used to form a 32 X 32 matrix with the CSE data, and a principle-component analysis with a varimax rotation was conducted. Means, standard deviations, and estimates of internal-consistency (Cronbach's Alpha) were computed for the newly derived CSE subscales, the total CSE score, and the CAS subscales. Five positively worded items from the CAS Computer Anxiety subscale were reversed so that higher scores represented higher degrees of anxiety. Correlation's among the four CSE subscales and the two CAS subscales were also calculated. High/low frequency of computer use was determined by selecting respondent's who scored 1 standard deviation above (high user) and 1 standard deviation below (low user) the mean. An independent measures t test was then performed with each of the CSE and CAS subscales to determine differentiation amongst high/low computer users.

Results

Factorial Validity and Reliability

The principal components analysis with varimax rotation produced a 4 factor solution that explained 69.6% of the variance. Applying the criterion used by Murphy et al.

in the development of the CSE, items were presented for the factor on which the factor pattern structure coefficient was the highest. Table 1 depicts the four factors and factor pattern structure coefficients. Factor I accounted for most of the covariance (55.3%) with 10 factor pattern structure coefficients ranging from .53 to .80. This factor was interpreted as representing File and Software Management. The second factor consisted of 12 items

Table 1
Four Factor Varimax-Rotated Solution and Communalities for the Computer Self-efficacy Scale (N=216)

Item	Factor Pattern/Structure Coefficients				h^2
	I	II	III	IV	
Using a printer to make a "hardcopy" of my work.	.65	.23	.34	.10	.60
Copy a disk	.73	.42	.31	.11	.82
Copying an individual file.	.74	.38	.33	.17	.84
Getting the software up and running	.54	.31	.45	.30	.68
Adding and deleting information from a data file.	.75	.31	.32	.19	.80
Storing software correctly.	.53	.48	.41	.14	.71
Getting rid of files when they are no longer needed.	.80	.23	.20	.11	.75
Organizing and managing files.	.66	.52	.24	.15	.79
Using the user's guide when help is needed.	.57	.35	.11	.31	.55
Entering and saving data (numbers or words) into a file.	.65	.22	.40	.34	.75
Understanding terms/words relating to computer hardware	.30	.55	.44	.38	.72
Understanding terms/words relating to computer software.	.37	.62	.40	.20	.72
Learning to use a variety of programs (software).	.40	.58	.48	.12	.73
Learning advanced skills within a specific program (software). *	.30	.42	.08	.01	.27
Using the computer to analyze number data. *	.32	.67	.16	.35	.69
Writing simple programs for the computer	.19	.62	-.02	.24	.48
Describing the function of computer hardware (keyboard, CPU, etc.).	.21	.64	.45	.23	.70
Understanding the three stages of data processing: input, processing, output.	.17	.54	.44	.38	.65
Getting help for problems in the computer system.	.41	.53	.37	.27	.65
Explaining why a program (software) will or will not run on a given computer.	.25	.76	.17	.19	.70
Using the computer to organize information.	.54	.58	.32	.07	.74
Troubleshooting computer problems.	.27	.75	.15	.29	.74
Working on a personal (micro) computer.	.47	.39	.49	.19	.64
Handling a floppy disc correctly.	.53	.30	.53	.20	.70
Making selections from an onscreen menu.	.36	.37	.58	.13	.62
Moving the cursor around the monitor screen.	.21	.18	.76	-.04	.66
Using the computer to write a letter or essay.	.28	.07	.79	.13	.73
Escaping/exiting from the program/software.	.50	.09	.58	.42	.77
Calling-up a data file to view on the monitor screen.	.45	.18	.57	.41	.73
Logging onto a mainframe computer system	.19	.36	.14	.80	.83
Working on a mainframe computer.	.15	.26	.03	.81	.75
Logging off the mainframe computer system.	.13	.16	.19	.82	.75

Note. * denotes items omitted from the Torkzadeh and Koufteros (1994) study.

with coefficients ranging from .42 to .76. These items represent advanced-level computer skills. Factor III clearly consisted of 6 items with pattern structure coefficients from .49 to .79. The items defining this factor represent beginning-level computer skills. A seventh item, "handling a floppy disk correctly", contributed equally to this factor, and that of File and Software Management; in line with the Murphy et al. (1989) and Harrison and Rainer (1992a) studies, this item was deemed to represent beginning-level computer skills. The final factor was defined by 3 items which clearly represent mainframe skills. The coefficients for this factor ranged from .80 to .82.

The factor structure found through this study was similar to the one identified by Torkzadeh and Koufteros with the following exceptions: 1) three items previously loaded on beginning computer skills are now reported on Factor I File and Software Management ("using a printer to make a 'hardcopy' of my work", "storing software correctly", and "entering and saving data into a file"); 2) "explaining why a program (software) will or will not run on a given computer" loaded on advanced-level computer skills, not File and Software Management; and 3) "using the user's guide when help is needed" loaded on File and Software Management rather than Advanced-Level Computer Skills. The two items previously omitted from the Torkzadeh and Koufteros study, "learning advanced skills within a specific program" and "using the computer to analyze number data" both loaded on Factor II, Advanced-level computer skills.

The mean scores and standard deviations for the derived factors are presented for each of the subscales of the Computer Self-efficacy Scale (File and Software Management, Beginning Computer Skills, Mainframe Skills, and Advanced-level Computer Skills) in Table 2. Reliability coefficients yielded by the sample are also reported.

Convergent and Discriminant Validity

Table 2 also presents the Pearson product moment correlation coefficients between the CSE subscales and the CAS subscales. As predicted, a negative correlation was found between the four CSE subscales and the CAS Computer Anxiety subscale. The CSE, in its

Table 2
Descriptive Statistics and Intercorrelations Among the Computer Self-efficacy Scale and Computer Attitude Scales

Subscale	CSE	1	2	3	4	5	6
Computer Self-efficacy							
CSE Total	(.97)						
1. File and Software Management	.95	(.95)					
2. Advanced-level Computer Skills	.95	.85	(.93)				
3. Beginning Computer Skills	.89	.85	.77	(.91)			
4. Mainframe Skills	.66	.52	.60	.51	(88)		
5. CAS Computer Anxiety	-.76	-.73	-.72	-.69	-.50	(.92)	
6. CAS Computer Confidence	.79	.74	.76	.71	.52	-.91	(.90)
Mean	122	39	42	30	10	19	41
Standard deviation	24	9	10	4	3	7	6

Notes. Cronbach's coefficient alpha reported in parentheses. All correlation's are significant at $p<.001$

entirety, exhibited a significant correlation with the CAS Computer Confidence and Computer Anxiety subscales, $r = 79$, and $r = -.76$ respectively ($p < .001$). The power values (Cohen, 1988) were all greater than .995. Further, the reported correlation coefficients would have been as statistically significant even with a sample size as small as $n = 15$.

Known Group Differential

Previous studies have revealed a positive relationship between self-efficacy and computer experience. The findings from this research support this supposition. After eliminating from the study computer users within 1 SD of the mean (mean 15.40, SD = 5.91 at work; mean 18.32, SD = 7.05 at home), t test statistics on the remaining respondents revealed that the CSE did differentiate between high/low computer users. As Table 3 shows, all four of the newly derived CSE subscales differentiated between high and low computer users both at work and at home.

Table 3
Means, Difference Between Mean Scores, and t Statistics for Computer Self-efficacy and Computer Attitude Scale Subscales by High and Low Frequency of Computer Usage at Home and Work

	Mean Scores					
Subscale	High User	Low user	Difference	t	df	p
Home						
File and Software	45.92	31.47	-14.45	-7.88*	22.45	0.001
Beginning Skills	49.85	33.42	-4.1556	-8.20	71	0.001
Mainframe	32.94	25.47	-7.47	-7.15*	22.87	0.001
Advanced Skills	11.22	8.94	-2.27	-2.97	71	0.004
CSE Total	139.94	99.31	-40.62	-7.60*	23.97	0.001
Computer Anxiety	15.03	25.73	10.69	6.62	71	0.001
Computer Confidence	45.05	35.05	-10.00	-7.64	70	0.001
Work						
File and Software	47.50	31.41	-16.08	-8.17*	29.28	0.001
Beginning Skills	56.08	34.23	-21.84	-9.89*	26.25	0.001
Mainframe	33.83	26.72	-7.10	-6.80*	30.38	0.001
Advanced Skills	12.75	8.86	-3.88	-4.60	61	0.001
CSE Total	150.16	101.23	-48.93	-9.08*	27.83	0.001
Computer Anxiety	14.16	25.16	10.99	5.72*	22.93	0.001
Computer Confidence	47.25	35.44	-11.81	-8.44*	31.54	0.001

Note. * Unequal variances (Levenes Test for Equality of Variances).

Discussion

The purpose of the present research was to explore the psychometric properties of the Computer Self-efficacy Scale (CSE). Specific attention was given to the factorial structure, and convergent and discriminant validity of the CSE. Estimates of the reliability of the data yielded by the CSE were also obtained, along with an investigation into the CSE's ability to differentiate differentiate between two groups with different amounts of computer usage experience.

Principal components analysis of the CSE scale revealed a meaningful four factor solution similar to that reported by Torkzadeh and Koufteros (1994). However, fewer items loaded on Factor 3, Beginning-level Computer Skills, than previously reported. The seven remaining items, such as "moving the cursor around the monitor screen", are representative of fundamental computer-related competencies associated with menu options. File and Software Management is, as the name suggests, a broader domain than previously identified. Results of this study also prove that the CSE correlates with

computer confidence and computer anxiety. The magnitude of these correlation's clearly supports the convergent and discriminant validity of the newly derived factors of the CSE. Furthermore, the CSE lends support to previous research which note that the amount of experience a person has with computers can impact their judgment of self-efficacy for computer-related tasks: thus, it appears that the CSE is measuring the same construct to a similar degree for high and low computer users. The results of this research, therefore, show that the Computer Self-efficacy scale is suitable for use in research and evaluation if the construct under inspection is that of computer self-efficacy. It must be noted, however, that the domains are specific and any attempt to generalize results across other computer-related knowledge and skill areas is not recommended.

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